

## **10. DEVELOPMENT OF ALTERNATIVES**

Remedial alternatives are developed in this section. Alternatives were developed by selecting a representative process option for each GRA and technology type from those retained after screening in Section 9. Selected process options were then combined to formulate a range of remedial alternatives potentially capable of meeting RAOs, given the contaminant types and exposure pathways of concern specific to each site. Technology types comprising alternatives for each site are shown in Table 10-1.

### **10.1 Alternative 1: No Action with Monitoring**

This alternative could be applied to any OU 4-13 site of concern. Formulation of a No Action with Monitoring alternative (Alternative 1) is required by the National Contingency Plan (NCP) [40 CFR 300.430 (e)(6)] and guidance for conducting feasibility studies under CERCLA (EPA 1988). The No Action with Monitoring alternative serves as the baseline for evaluating other remedial action alternatives. This alternative can include environmental monitoring (groundwater, air, and soil) for up to 100 years after low level waste disposal site closure, but does not include institutional controls to reduce potential exposure pathways, such as fencing or deed restrictions (EPA 1988). Five-year reviews are included, as required under the NCP.

### **10.2 Alternative 2: Institutional Control**

An Institutional Control alternative (Alternative 2) was developed comprised of institutional controls implemented by the INEEL and assumed to remain in effect for up to 100 years; and deed restrictions that would limit uses of property, if transferred from government control to private ownership, which could remain effective indefinitely. This alternative could be applied to any OU 4-13 site of concern. Management practices currently implemented at OU 4-13 contaminated soil sites would continue and would additionally include site inspection and monitoring. Actions under this alternative would implement access restrictions during the institutional control period using fences and signs, radiation surveys at sites where radionuclides remain in place, and routine site inspection and monitoring for animal burrows, erosion, etc. Surface water diversion is included to minimize the potential for surface water accumulating at the site, and would include inspecting and maintaining drainage systems.

If the property were ever transferred to non-government ownership, the U.S. Government would create a deed for the new property owner that would include information required under Section 120(h) of CERCLA. The deed shall include notification disclosing former waste management and disposal activities that occurred on the site; and shall, in perpetuity, limit property uses through restrictive covenants or easements to those determined to not result in human health risks above allowable levels.

Any remedial alternative relying on institutional controls requires an Institutional Control Plan, prepared and submitted as an enforceable provision of the ROD (EPA 1998). The Plan must specify what must be done to impose and maintain the required land use restrictions and/or other controls. Institutional controls would be reviewed annually for the first 5 years following site closure. The need for further institutional controls would be evaluated and determined by the agencies during subsequent 5-year reviews.

**Table 10-1.** Remedial alternatives for OU 4-13 contaminated soil sites.

GRA/Technology Type/ Process Options	Remedial Alternatives				
	1 No Action With Monitoring	2 Institutional Control	3a Excavate/ Treat/ICDF Disposal	3b Excavate/Treat/ Off-INEEL Disposal	4 Containment in Place- ET-Type Cover
<b>Monitoring</b>					
Soil monitoring	X	X			X
<b>Institutional Controls/Access Restrictions</b>					
Fences		X			X
Deed restrictions		X			X
Institutional controls/ maintenance		X			X
Cap integrity monitoring and maintenance					X
Surface water diversions		X			X
<b>Excavation</b>					
Backhoes and dozers			X	X	
<b>Containment/ Capping</b>					
ET-type barrier					X
SL-1-type barrier					
RCRA-type barrier					
Native soil barrier					
Native soil backfill			X	X	
Concrete cover					
<b>Disposal/ Landfilling</b>					
RWMC					
ICDF			X		
Backfill existing disposal pond					
Offsite mixed waste TSDF				X	

**Table 10-1.** (continued).

GRA/Technology Type/ Process Options	Remedial Alternatives				
	1 No Action With Monitoring	2 Institutional Control	3a Excavate/ Treat/ICDF Disposal	3b Excavate/Treat/ Off-INEEL Disposal	4 Containment in Place- ET-Type Cover
<b>In Situ Treatment</b>					
In situ chemical stabilization					
ISV					
Phytoremediation					
<b>Ex Situ Treatment</b>					
Segmented gate			CFA-08, only (on INEEL)	CFA-08, only (on INEEL)	
Stabilization			CFA-04, -10 only (on-INEEL)	CFA-04, -10 only (off- INEEL)	
Plasma torch					
Thermal desorption					
Mercury retort					

### **10.3 Alternatives 3a and 3b: Removal, Treatment, and Onsite Disposal; and Removal, Treatment, and Offsite Disposal**

Remedial alternatives incorporating treatment were developed, to meet EPA expectations that treatment be used "...to address principal threats posed by a site, wherever practicable. Principal threats for which treatment is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile compounds" (40 CFR 300.430). Treatment would also be required for soils with RCRA hazardous characteristics, present at CFA-04 and -10, which were removed from the AOC.

Treatment alternatives were developed to allow risk managers to determine their cost-effectiveness and practicability, relative to other alternatives. These alternatives could be applied to any OU 4-13 site, however the nature and extent of contamination are sufficiently different that details specific for each site are discussed below.

#### **10.3.1 Alternative 3a: Removal and Onsite Treatment and Disposal**

**10.3.1.1 CFA-04.** The CFA-04 disposal pond is estimated to contain a relatively small volume (609 m<sup>3</sup> [796 yd<sup>3</sup>], 8.7% of the total volume of soil contaminated above PRGs at the site) of RCRA hazardous wastes (D009). This alternative would consist of the following actions:

- Characterizing soils and excavating all soil and sediments from the pond exceeding human health and ecological risk PRGs, to a depth of at least 0.9 m (3.0 ft) below the bottom of the pond (3 m [10 ft] bgs); basalt at depths less than 0.9 m (3.0 ft) bgs would not be excavated
- Transporting soils contaminated above PRGs to the ICDF
- Stabilization in Portland cement and disposal of RCRA-hazardous soils at the ICDF
- Direct disposal of non-RCRA-hazardous soils at the ICDF
- Verification sampling to ensure that no contamination exceeding PRGs remained
- Returning soils contaminated at less than PRGs to the excavation
- Backfilling the excavation with clean native soil, with a final sloping finish grade to divert water, and revegetating the site
- Implementing 5-year reviews and deed restrictions, if contamination above PRGs remained.

Other treatment or disposal process options might potentially be selected in the ROD and/or during remedial design. No long-term monitoring would be required for the CFA-04 pond after completing the remediation. Backhoes and dozers were assumed to be used for excavating contaminated soil and sediments.

**10.3.1.2 CFA-08.** The only COC for CFA-08 is Cs-137. The representative process option for radionuclide-contaminated soils is segmented gate separation (SGS). A pilot-scale treatability study will be performed in 1999 to assess the effectiveness and technical feasibility of SGS treatment of Cs-137-contaminated INEEL soils. If SGS treatment is not determined to be cost effective or technically feasible,

then treatment would be eliminated from this alternative for CFA-08 and soils would be disposed of directly at the ICDF. This alternative would consist of the following actions:

- Characterizing soils and excavating all soil and sediments from the drainfield exceeding human health risk PRGs, to a depth of at least 3 m (10 ft) bgs; basalt at depths less than 3 m (10 ft) bgs would not be excavated.
- Sludges remaining in drainfield feeder lines would be allowed to drain into soil during excavation. Drainfield tiles and other debris would then be excavated, crushed and screened to reduce the size of materials to less than two inches nominal diameter.
- Processing soils and crushed debris through the SGS to separate out material contaminated with Cs-137 at activities above the PRG.
- Transporting all soils above PRGs to the ICDF.
- Verification sampling to ensure that no contamination exceeding PRGs remained.
- Returning soils contaminated at less than PRGs to the excavation.
- Backfilling the excavation with clean native soil, with a final sloping finish grade to divert water, and revegetating the site.
- Implementing 5-year reviews and deed restrictions, if contamination above PRGs remained.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the ICDF.

**10.3.1.3 CFA-10.** All soils at CFA-10 were assumed to be RCRA characteristic wastes (D008 for Pb) for cost estimating purposes for this alternative. Contamination is assumed to extend to 0.15 m (0.5 ft) bgs. This alternative would consist of the following actions:

- Characterizing soils and excavating all soil exceeding human health and ecological risk PRGs
- Transporting soils contaminated above PRGs to the ICDF
- Stabilization in Portland cement and disposal of RCRA-hazardous soils at the ICDF
- Direct disposal of non-RCRA-hazardous soils at the ICDF
- Verification sampling to ensure that no contamination exceeding PRGs remained
- Returning soils contaminated at less than PRGs to the excavation
- Backfilling the excavation with clean native soil, with a final sloping finish grade to divert water, and revegetating the site.

Other treatment or disposal process options might potentially be selected in the ROD and/or during remedial design. No long-term monitoring would be required after completing the remediation. Backhoes and dozers were assumed to be used for excavating contaminated soil and sediments.

### **10.3.2 Alternative 3b: Removal, Treatment and Disposal Off-INEEL**

**10.3.2.1 CFA-04.** This alternative would consist of the actions described in Section 10.3.1.1 for Alternative 3a for this site, except that soils would be transported to, and treated and disposed of at an off-INEEL MLLW TSDF.

Other treatment or disposal process options might potentially be selected in the ROD and/or during remedial design. No long-term monitoring or institutional control would be required for the CFA-04 pond after completing the remediation. Backhoes and dozers are assumed to be used for excavating contaminated soil and sediments.

**10.3.2.2 CFA-08.** This alternative would consist of the actions listed in Section 10.3.1.2 for Alternative 3a for this site, except that all soils contaminated at levels above PRGs would be transported to an off-INEEL LLW landfill for disposal.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the off-INEEL disposal facility.

**10.3.2.3 CFA-10.** This alternative would consist of the actions listed in Section 10.3.1.3 for Alternative 3a for this site, except that all soils above PRGs would be transported to an off-INEEL RCRA Subtitle C landfill. Soils determined to be RCRA-hazardous would be stabilized prior to disposal, while nonhazardous soils contaminated above PRGs would be disposed of directly at the off-INEEL facility. Soils contaminated at levels below PRGs would be returned to the excavation. Institutional controls were assumed to not be required, since all contamination would be removed.

## **10.4 Alternative 4: Containment and Institutional Controls**

This alternative could be applied to any OU 4-13 site. The alternatives developed for containing contaminants at OU 4-13 soil release sites are based on capping technologies designed to meet RAOs by eliminating exposure pathways identified in the baseline risk assessment (BRA). Human health risks due to Cs-137 exposure at CFA-08 will decline to unrestricted release levels within 189 years through natural radioactive decay. However, human health and ecological risks due to toxic metals at CFA-04 and -10 will not. Containment technologies must be designed to maintain integrity for the period of time that unacceptable cumulative exposure risks will be present. The functional life of a particular cover design depends on how long potential failure mechanisms including erosion, subsidence, geosynthetic failure, infiltration, biotic and human intrusion, and others can be delayed.

The containment option must also meet RCRA 40 CFR 264.310 (a)(1-5), considered relevant and appropriate for CFA-04 and -10, where RCRA hazardous wastes are present. These include functional requirements that the cap:

- Provide long-term minimization of migration of liquids through the closed landfill
- Function with minimum maintenance

- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settling and subsidence so that the cover's integrity is maintained
- Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The ET-type cap was determined to best meet functional requirements and was selected as the representative capping process option for Alternative 4 for all sites. The preconceptual design identified for the containment alternative in this FS would be developed during remedial design and modified as needed to meet defined functional and operational requirements, with the concurrence of regulatory agencies. Design and construction details for Alternative 4 specific to each OU 4-13 site of concern are discussed below.

Constructing the ET-type of cover at CFA-04 would require backfilling the pond with clean native soil to bring the level to grade, with compaction. A foundation of approximately 0.46 m (18 in.) of compacted soil would next be placed in lifts. The foundation and all overlying layers would be sloped 2 to 4% from the centerline of the cap. The gravel-cobble biobarrier/capillary barrier would be constructed over the foundation layer next, with approximately 0.15 m (0.5 ft) of gravel overlying 0.76 m (2.5 ft) of cobbles. A geotextile layer, or a graded filter bed, would be placed on top of the upper gravel layer to prevent overlying soil from entering the gravel. Successive lifts of compacted native soil would be added next, with a total thickness of 1.25 m (4.1 ft). A surface layer of 0.15 m (0.5 ft) of soil with a rock mulch and added fertilizer for establishing vegetation and resisting erosion would be graded and completed with a 2 to 4% slope. The surface would be vegetated with a mix of grasses found to be readily established and sustained on disturbed soils on the INEEL (DOE 1989).

Constructing this type of cover at CFA-08 and -10 would first require clearing and grubbing the site, then constructing the foundation with successive lifts of native soil applied with compaction between lifts. Minimum cover thickness would be approximately 2.8 m (9 ft) at the perimeter of the contaminated area, and thicker at the centerline due to the sloped layers. For example, at CFA-08 with dimensions of approximately 61 × 305 m (200 × 1,000 ft), the centerline thickness would be at least 4.0 m (13 ft). The surface would be graded to divert water, rock mulch added and the finished surface vegetated with appropriate grasses to minimize erosion and promote evapotranspiration.

Institutional controls, as for Alternative 2, would be implemented. Additionally, the cap would be maintained during the 100-year institutional control period.

## 10.5 References

- DOE, 1989, *Guidelines for Revegetation of Disturbed Sites at the INEL*, DOE/ID-12114, June.
- DOE, 1991, *Declaration for the Warm Waste Pond at the Test Reactor Area at the Idaho National Engineering Laboratory*, December.
- DOE, 1993, *Treatability Test Plan for the 200-BP-1 Prototype Surface Barrier*, DOE/RL-93-27, Rev. 0, U.S. Department of Energy, Richland Field Office, Richland, Washington.
- DOE, 1994a, *Proposed Plan for the 200-BP-1 Operable Unit at Hanford, Richland, Washington*, DOE/RL-93-72, Revision 0, U.S. Department of Energy Richland Operations, January.

- EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.
- EPA, 1992, *Superfund Record of Decision System Database*, managed by the U.S. Environmental Protection Agency, Office of Emergency and Remedial Response.
- EPA, 1998, "Interim Final Policy on the Use of Institutional Controls at Federal Facilities," Memorandum, U.S. Environmental Protection Agency Region 10, September 15, 1998.
- Jessmore, P. J., 1995, *Engineering Evaluation/Cost Analysis for Operable Unit 10-06 Radionuclide-Contaminated Soils Removal Action at the Idaho National Engineering Laboratory*, INEL-95/0259, Rev. 0, June.
- LMITCO, 1995, *Remedial Investigation/Feasibility Study Report for Operable Units 5-05 and 6-01 (SL-1 and BORAX-1 Burial Grounds)*, Lockheed Martin Idaho Technologies Company, INEL-95/0027, Revision 0, March.
- Radian Corporation and Morrison Knudsen Corporation, 1993, *Texas Low-Level Radioactive Waste Disposal Facility: Project Summary*, TX-RA-0728, December.
- Reith, C. C., and J. A. Caldwell, 1990, *Vegetative Covers for UMTRA Project Disposal Cells*, presented at the Department of Energy Remedial Action Program Conference, Albuquerque, New Mexico, April.
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## 11. SCREENING OF ALTERNATIVES

This section discusses screening of remedial alternatives identified for OU 4-13 sites in the preceding section. In accordance with the CERCLA RI/FS guidance (EPA 1988), each remedial alternative identified in Section 8 is evaluated against three general criteria: effectiveness, implementability, and cost. A description of each screening criterion follows:

- **Effectiveness**—Effectiveness is the most important aspect of the screening evaluation. This criterion is used to assess how well an alternative would provide both short-term and long-term protection of human health and the environment, including how well the alternative would meet RAOs. In this context, short-term refers to the implementation period and long-term refers to the period thereafter. Also included, as a measure of effectiveness, is the ability to reduce the toxicity, mobility, and volume of the contaminated material.
- **Implementability**—This criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical feasibility includes the construction, operation, and maintenance required to implement the remedial action. Administrative feasibility includes the regulatory and public acceptance, availability of services, and specialized equipment and personnel requirements. Short-term implementability refers to the implementation period and long-term refers to the operation, maintenance, and institutional control period thereafter.
- **Cost**—This criterion is used to assess the relative magnitude of capital and operating costs for an alternative during the specified period of active control. Short-term cost refers to the implementation period and long-term refers to the operation, maintenance, and institutional control period thereafter.

Detailed descriptions of these criteria are given in the guidance for conducting feasibility studies under CERCLA (EPA 1988).

A description of each alternative developed for each site or site grouping in Section 10 is provided in order to evaluate effectiveness, implementability, and cost. These descriptions are intended to provide sufficient detail to distinguish between alternatives relative to the three screening criteria. Each description provides general information regarding the technologies comprising of an alternative and the applicability of those technologies to the conditions at the OU 4-13 site groups. The following subsections provide a description of each alternative and an evaluation based on the three screening criteria.

### 11.1 Alternative 1: No Action With Monitoring

#### 11.1.1 Description

This alternative could be applied to any OU 4-13 site. The NCP [40 CFR 300.430 (e)(6)] requires consideration of a No Action alternative to serve as a baseline for evaluating other remedial alternatives. No land-use restrictions, controls, or active remedial measures would be implemented at the site. Risk levels would be reduced only through radioactive decay or other natural processes. Environmental monitoring can be considered part of a No Action alternative during the time the DOE has institutional control of the INEEL, which includes the site operational period and at least 100 years following site closure. The No Action with Monitoring alternative would therefore only be selected for sites where

contamination does not exceed unacceptable risk levels, and where the alternative would comply with ARARs.

Environmental monitoring would be performed to detect contaminant migration and to identify exposures via soil and groundwater. Monitoring results would be used to determine the need for any future remedial actions necessary to protect human health and the environment. Monitoring would be conducted until future reviews determine that further monitoring is not required. Radiation surveys would be performed at sites where contaminated soil and sediments remain in place as part of this remedial action until WAG-wide comprehensive environmental monitoring programs are implemented. Five-year reviews are included, as required under the NCP.

#### **11.1.2 Evaluation**

The No Action with Monitoring alternative would be easily implemented at all sites at moderate costs. However, results of the BRA indicate that OU 4-13 sites of concern present unacceptable risks to human health and the environment and therefore the No Action with Monitoring alternative is ineffective and does not meet RAOs. Long-term monitoring costs would be relatively low. Estimated costs for the No Action with Monitoring alternative for each site are provided in Table 11-1. Detail and summary sheets are provided in Appendix M.

### **11.2 Alternative 2: Institutional Control**

#### **11.2.1 Description**

This alternative could be applied to any OU 4-13 site. Alternative 2 consists of the following actions to protect human health and the environment from potential risks associated with OU 4-13 sites:

- Surface water diversion
- Access restrictions
- Long-term environmental monitoring as for the No Action with Monitoring alternative
- Deed restrictions to be implemented if the property were ever transferred to non-federal ownership
- Five-year reviews.

Surface water diversion measures would be used to prevent ponding on the sites. Contour grading, drainage ditches, and other appropriate measures would be used to direct surface water away from the sites to existing natural or engineered drainage as required.

Access to the INEEL is currently restricted to ensure security and public safety. Since the OU 4-13 sites are located within the boundaries of the INEEL, Site-wide access restrictions would limit accessibility for at least 100 years. In addition, existing fences surrounding OU 4-13 sites would be maintained and replaced as necessary. Installing additional fences or relocating existing fences might also be necessary. Other access control measures may include (but are not limited to) warning signs, assessing trespassing fines, and establishing training requirements for persons allowed access. Land-use restrictions may be specified in the event that government control of the INEEL is not maintained throughout the institutional control period.

**Table 11-1.** Net present value of capital, operating and maintenance, and total costs for OU 4-13 remedial alternatives.

Site	Alternative 1: No Action with Monitoring	Alternative 2: Institutional Controls	Alternative 3a: Excavate, Treat and ICDF Dispose/Institutional Controls	Alternative 3b: Excavate, Treat and Off-INEEL Dispose/Institutional Controls	Alternative 4: Containment with ET-Type Cap and Institutional Controls
<b>CFA-04</b>					
Capital	881,000	1,398,000	6,732,000	12,636,000	4,830,000
O&M	229,000	3,101,000	229,000	229,000	3,162,000
Total	1,110,000	4,499,000	6,961,000	12,865,000	7,992,000
<b>CFA-08</b>					
Capital	881,000	1,440,000	30,756,000	36,549,000	6,508,000
O&M	229,000	3,420,000	229,000	229,000	3,486,000
Total	1,110,000	4,860,000	30,985,000	36,778,000	9,994,000
<b>CFA-10</b>					
Capital	881,000	1,245,000	1,380,000	1,442,000	2,145,000
O&M	0	2,664,000	0	0	2,715,000
Total	881,000	3,909,000	1,380,000	1,442,000	4,860,000

Site inspections, fence maintenance, and surface drainage would be implemented. Monitoring and inspection results would be considered during 5-year reviews to determine if active remediation was required at specific sites. Deed restrictions would be used to limit future uses of the property, if it were ever transferred to nongovernmental ownership.

### **11.2.2 Evaluation**

The Institutional Control alternative is considered to be easily implemented for the institutional control period, since the specified actions would essentially continue existing management practices at the OU 4-13 sites. Worker protection measures including ALARA currently implemented under DOE orders will remain effective for the duration of occupational activities. Soil monitoring would be performed, as for the No Action with Monitoring alternative. Site inspections were assumed to be performed twice yearly, while soil cover maintenance, surface water diversion, and fence maintenance would be performed only on an as-needed basis. These controls are considered to be effective for protecting human health during the 100-year period of institutional control.

Risks to human health will remain at unacceptable levels after 100 years at all sites of concern, and ecological risks at CFA-04 and -10 will also remain at unacceptable levels. Ecological risks at CFA-04 and -10 would not be significantly reduced by institutional controls or deed restrictions. The Institutional Control alternative is therefore considered to meet RAOs for future residents, but not for protection of the environment, at OU 4-13 sites. This alternative is screened from further consideration for CFA-04 and -10, because it does not meet the ecological risk RAO for those sites, but is retained for CFA-08.

## **11.3 Alternative 3a: Conventional Excavation/Ex Situ Treatment/ICDF Disposal/Institutional Control**

### **11.3.1 Description**

This alternative could be applied to any OU 4-13 site. Details are provided for each site of concern, since COCs differ for each site.

**11.3.1.1 CFA-04.** COCs include mercury for human health risks, and copper and mercury for ecological risks. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Soils exceeding human health and/or ecological PRGs would be excavated, as described previously. Deed restrictions and 5-year reviews would be implemented where contamination above PRGs remained.

Excavated soils would be sampled and analyzed for TCLP. Based on sampling results, approximately 612 m<sup>3</sup> (800 yd<sup>3</sup>) were assumed to fail TCLP for mercury, and total mercury concentrations measured are all below 260 mg/kg (low-mercury subcategory). RCRA-hazardous soils would be transported to the ICDF for stabilization in Portland cement and disposal. Non-hazardous soils above PRGs would be shipped to the ICDF and disposed of directly.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Five-year reviews and deed restrictions would be required if contamination above PRGs remained.

**11.3.1.2 CFA-08.** Human health risk COCs includes only Cs-137, and no ecological risks were identified. The treatment option for these soils and debris is screening, crushing and segmented gate

sorting on site to remove radionuclides contaminated at greater than the PRG of 23 pCi/g Cs-137. Soils contaminated at higher levels would be disposed of at the ICDF, while soils contaminated at lower levels would be returned to the excavation.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Deed restrictions and 5-year reviews would be implemented if contamination above PRGs remained.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the ICDF.

**11.3.1.3 CFA-10.** Human health and ecological risk COCs include only Pb. Soil would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Excavated soils would be sampled and analyzed for TCLP, and for total Pb. The RCRA-hazardous soils would be transported to the ICDF for stabilization in Portland cement and disposal. Nonhazardous soils above PRGs would be shipped to the ICDF and disposed of directly. Based on 1998 RCRA characterization results, all CFA-10 soils are assumed to be hazardous. Soils with total lead concentrations less than PRGs would be returned to the excavation.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Institutional controls would not be required at CFA-10 after excavation and disposal, since all soil above PRGs would be excavated.

## **11.3.2 Evaluation**

The short-term effectiveness of this alternative for protecting human health is moderate for all sites. Exposure of workers and environmental receptors to COCs during excavation, transportation, treatment, and disposal could be controlled using administrative and engineering controls including appropriate personal protection equipment (PPE), dust control, and other measures. The addition of treatment increases the potential for worker exposures, and the extent of controls required.

Long-term protection of human health and the environment is high. All COCs above allowable levels would be removed from the sites, immobilized, and disposed in a secure landfill, thereby eliminating all WAG 4 risk to human health and the environment above allowable levels. Institutional controls would ensure the long-term effectiveness of the remedy at any site where contamination above PRGs remained.

Technical and administrative implementability of this technology is considered moderate. Cement stabilization has been previously implemented at the INEEL, and segmented gate separation will be evaluated at pilot scale in 1999. However, treatment increases the overall complexity of the alternative, which reduces implementability. No long-term monitoring or care would be required at the sites, assuming all contamination was removed to a depth of 3 m (10 ft) bgs. However, deed restrictions and 5-year reviews would likely be required at CFA-04 and -08, where contamination above PRGs may remain at depths greater than 3 m (10 ft) bgs.

Short-term costs of the treatment process component of this alternative vary. Costs for stabilization in Portland cement and segmented gate separation are relatively moderate and low, respectively. Estimated capital and operating costs for Alternative 4a for each site are provided in Table 11-1.

## 11.4 Alternative 3b: Excavation/Treatment and Disposal Offsite/Institutional Controls

### 11.4.1 Description

This alternative could be applied to any OU 4-13 site. Details are provided for each site of concern, since COCs and exposure pathways differ.

**11.4.1.1 CFA-04.** The COCs include primarily mercury for human health risks, and copper and mercury for ecological risks. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Soils exceeding human health and ecological PRGs would be excavated, as described previously.

The CFA-04 disposal pond soils were determined to have radioactivity added by DOE activities (i.e., “rad-added”), based on analyzing 11 pond soil samples using DOE-ID technical procedure (TPR)-713. This method compares measured activities to a background envelope, established either as the 95% UCL of all measurements for a given set of samples; or by direct comparison to actual measured INEEL background values, cited in Appendix C, Table 1, of the procedure. The second method specifies distinctly different procedures for soil and other materials. The analysis identified Cs-137 as present in two samples, at activities greater than the 95% UCL and therefore defined as resulting from DOE activities<sup>a</sup>. However, measured activities are less than the actual measured INEEL background values and the soils may not be considered “rad-added” if this method had been used. The soils are assumed to be “rad-added” for purposes of this report until this issue is resolved.

Excavated soils would be sampled and analyzed for TCLP. Based on sampling results, approximately 612 m<sup>3</sup> (800 yd<sup>3</sup>) were assumed to fail TCLP for mercury, and total mercury concentrations are all below 260 mg/kg (low-mercury subcategory). RCRA-hazardous soils exceeding PRGs would be shipped in bulk by rail to a representative MLLW TSDF, stabilized in Portland cement and disposed of there. Nonhazardous soils would be disposed of directly. Institutional controls, consisting of deed restrictions and 5-year reviews, were assumed to be required to ensure the long-term effectiveness of the remedy.

**11.4.1.2 CFA-08.** Human health risks COCs include only Cs-137 and no ecological risks were identified. The treatment option for these soils is onsite screening, crushing and segmented gate sorting to remove radionuclides contaminated at greater than the PRG of 23 pCi/g Cs-137. Soils contaminated at higher levels would be shipped in bulk by rail to a representative off-INEEL MLLW landfill for disposal there, while soils contaminated at lower levels would be returned to the excavation. Institutional controls, consisting of deed restrictions and 5-year reviews, were assumed to be required to ensure the long-term effectiveness of the remedy.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the offsite facility.

**11.4.1.3 CFA-10.** Human health and ecological risk COCs include only Pb. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated.

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a. LMITCO Interdepartmental Communication TCS-025-98.

Excavated soils would be sampled and analyzed for TCLP, and for total Pb. All soils failing TCLP, and soils passing TCLP but exceeding lead PRGs, would be shipped in bulk by rail to Arlington, Oregon, stabilized in Portland cement, and disposed of there in a RCRA Subtitle C landfill.

All soils at CFA-10 (123 m<sup>3</sup> [161 yd<sup>3</sup>]) were assumed to be treated as RCRA-hazardous, for cost estimating purposes for this alternative. Soils with lead concentrations below PRGs could be returned to the site.

Following excavation and treatment, clean native fill soil would be trucked to each site and added to bring the level to grade and establish a sloping final surface to divert surface water. The site would be revegetated in accordance with INEEL guidelines. Institutional controls were assumed to not be required.

#### **11.4.2 Evaluation**

The short-term effectiveness of this alternative for protecting human health is moderate for all sites. Exposure of workers and environmental receptors to COCs during excavation, transportation, treatment, and disposal could be controlled using administrative and engineering controls including appropriate PPE, dust control, and other measures. All treatment and disposal would be performed offsite, except for segmented gate separation for CFA-08, at dedicated facilities with established worker protection administrative and engineering controls.

Long-term protection of human health and the environment is also high. All COCs above allowable levels would be removed from the INEEL, immobilized, and disposed of in a secure landfill, thereby eliminating all risk to human health and the environment above allowable levels. Institutional controls would ensure the long-term effectiveness of the remedy at any site where contamination above PRGs remained.

Technical and administrative implementability of SGS treatment is considered high. Required offsite treatment and disposal services are available. Segmented gate separation will be evaluated at pilot scale at the INEEL in 1999. No long-term care would be required at the sites, assuming all contamination was removed.

Short-term costs of the treatment process component of this alternative vary. Costs for offsite stabilization in Portland cement, and onsite segmented gate separation are relatively moderate and low, respectively. No long-term monitoring costs would be required; assuming all contamination would be removed from all sites to depths of at least 3 m (10 ft) bgs. Estimated capital and operating costs for the removal, treatment, and disposal alternative for each site are provided in Table 11-1.

### **11.5 Alternative 4: Containment and Institutional Control**

#### **11.5.1 Description**

This alternative could be applied to any OU 4-13 site. Alternative 4 consists of the following remedial actions to isolate contaminated soil at OU 4-13 disposal pond and buried soil contamination sites:

- Containment:
  - Evapotranspiration (ET)-type protective cover

- Institutional controls:
  - Long-term environmental monitoring as for the No Action with Monitoring alternative
  - Cover integrity monitoring and maintenance
  - Access restrictions
  - Surface water diversion
  - Deed restrictions
  - Five-year reviews.

Effectiveness of protective cover maintenance would be determined through monitoring. The protective cover would likely be monitored frequently during the first 6 to 12 months because potential problems (such as settling or subsidence) are most likely to occur within this period. After the initial 12 months, cover integrity monitoring may be performed annually or semiannually. Maintenance requirements include periodic removal of undesirable vegetation and burrowing animals and filling animal burrows. In addition, unacceptable erosion or subsidence would require repair of the affected area. Maintenance would be performed on an as-needed basis. Operations and maintenance goals would be defined during remedial design.

Environmental monitoring, cover integrity monitoring, access restrictions, and surface water diversion would be maintained at the contamination sites during the active institutional control period. Radiation surveys across and around CFA-08 would be performed to detect radionuclides mobilized by burrowing animals, erosion, or other natural processes. Cover integrity monitoring would be performed across and around all closed sites to assess maintenance requirements due to erosion, cracking, animal burrowing, or other observable deterioration of the cover. Access restrictions and surface water diversion measures would be implemented at all sites. Permanent warning markers would be placed on and around the cover. These institutional controls are assumed to remain effective for at least 100 years.

#### **11.5.2 Functional requirements.**

The ET -type cover is intended to meet the following functional requirements:

- Isolate waste for at least 500 to 1,000 years
- Minimize infiltration
- Minimum maintenance
- Inhibit inadvertent human intrusion and minimize plant and animal intrusion
- Protect surface water and groundwater.

The GWSCREEN calculations presented in the RI/BRA demonstrate that migration of contaminants from CFA sites to groundwater will not result in groundwater contamination in excess of risk-based levels. For purposes of this FS, groundwater protection is therefore assumed to not be a design

driver for the disposal ponds and buried contamination sites. However, any cover applied to CFA-04, -10, and -43 will likely be required to be functionally equivalent in infiltration control to a RCRA 3-layer cover, which can reduce infiltration rates to 1E-07 cm/sec, if not breached.

The ET-type cover design consists of four layers of natural media. This type of cap was specifically developed by DOE researchers to isolate low-level waste sites in arid climates, and exploits evapotranspiration demands that greatly exceed precipitation rates in the arid west. The materials used in each layer and the functions of each layer are described below, from the top down:

- The surface vegetation serves to remove water from the cap by transpiration. The rock mulch improves plant rooting by improving soil structure, and provides for additional wind and water erosion resistance. The grade of the surface serves to divert both precipitation and surface water run-on away from the waste site.
- The underlying native soil layer serves to store water, provide support for plants, and provides shielding from direct radiation.
- The biointrusion/capillary barrier, consisting of a layer of gravel overlying a layer of rock rip-rap or cobbles, serves two functions: (1) it provides a mechanical barrier to burrowing animals and an unfavorable medium for the advancement of plant roots and (2) it serves as a capillary break, acting to prevent infiltration downward until the overlying soil layer is saturated. This allows for storage during periods when the surface vegetation is inactive and evaporation rates are low.
- A bottom layer of impermeable asphalt, concrete or geosynthetic, if required for additional infiltration control.
- A foundation layer, serving to support the overlying cap.

Each component of the engineered cover (thickness of each layer, specifications of materials, etc.) would be evaluated and optimized during remedial design for application to the CFA sites.

Some RCRA landfill closure performance requirements could be considered relevant and appropriate for CFA-04 and -10, where RCRA hazardous wastes are present. These could include 40 CFR 264.310(a)(1-5) requirements that the cap:

- Provide long-term minimization of migration of liquids through the closed landfill
- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settling and subsidence so that the cover's integrity is maintained
- Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The 40 CFR 264.310 (b)(1,5,6) relevant and appropriate post-closure requirements could include:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events
- Prevent runoff and runoff from eroding or otherwise damaging the final cover
- Protect and maintain surveyed benchmarks.

### **11.5.3 Protective Cover Foundation**

Preparing a stable foundation over the disposal ponds and buried contamination sites before constructing a protective cover would be essential to ensure long-term integrity. Subsidence could breach the integrity of any cover selected as a remedial action. Appropriate foundation preparation measures to prevent any differential settling that would result in subsequent failure of the proposed cover are therefore included.

Preparing the foundation for CFA-04 would initially require backfilling the pond. This action would consist of adding clean fill as required to bring the pond to grade.

Preparing the foundation of CFA-08 and -10 would initially require clearing and grubbing the sites, removing vegetation and potentially decontamination and decommissioning (D&D) and removal of any interfering structures. The D&D and structure removal are assumed to be completed before cover foundation construction would begin.

Disturbed soils would be compacted before capping. Currently, available methods for preparing foundations considered applicable to the disposal ponds and buried soil contamination sites include vehicle compaction methods such as a vibratory steel-wheel drum roller. Vehicle compaction would be performed concurrently with moisture addition, to achieve better compaction and prevent airborne dust. Alternatively, fill material could be placed over contaminated surface soil to prevent generation of airborne contamination prior to vehicle compaction. The most appropriate method of foundation preparation would be determined during the remedial design phase.

### **11.5.4 Shielding Requirements**

Shielding requirements are discussed for CFA-08. INEEL soils and other geologic materials have previously been shown to readily attenuate Cs-137 dispersed in soil and debris. For purposes of this FS, shielding requirements developed for the WWP cells (DOE 1997) are assumed to be sufficient for all OU 4-13 sites, due to much higher activities in the WWP cells than present at any OU 4-13 sites. However, actual shielding requirements would be determined during remedial design.

The primary measure of effectiveness for the containment alternatives is the ability to satisfy the RAO of preventing exposure to penetrating radiation. Each cover design is therefore evaluated for the ability to provide sufficient shielding to reduce the dose rate from the surface of the site to background levels. Calculations provided in Appendix K of DOE (1997) determined that as little as 0.2 m (0.8 ft) total thickness of soil, and 0.2 m (0.6 ft) total thickness of cobbles, would reduce direct exposure risks to the 100-year resident to the 1E-04 level.

### **11.5.5 Evaluation**

This alternative is considered to be highly effective in preventing long-term exposure to contaminated soils at OU 4-13 sites, and would effectively reduce surface exposures to background levels for the duration of risks. The cover is designed for long-term isolation with minimal maintenance requirements. The engineered cover specified for this alternative would likely be effective in preventing biointrusion. This cover also affords a high level of inadvertent intruder protection, by both the mass and impenetrability of material overlying contaminated soils. This type of cap was determined using hydrologic modeling to provide infiltration control approximately equivalent to a RCRA three-layer cap (Keck et al. 1992).

Installation of this cover is technically feasible. Short-term effectiveness for protecting human health and the environment is moderate to high, based on worker exposure during construction of the cover. The foundation layer would provide direct radiation protection of workers during construction of the overlying layers at CFA-08.

All aspects of this alternative are considered readily implementable. Construction services are available on site or locally. Soil, basalt cobbles, and gravels construction materials are available onsite, or could be obtained offsite locally. Long-term inspection and maintenance requirements would include reestablishing vegetation as necessary, repairing erosion furrows and animal burrows, and removing undesirable plants. Long-term monitoring requirements including visual inspections and radiation surveys would be easily implemented during the institutional control period. Estimated capital and operating costs for the Engineered Barrier Containment Alternative for each site are provided in Table 11-1.

## **11.6 Screening of Alternatives Summary**

In the preceding subsections, each remedial action alternative was defined in order to provide sufficient qualitative information to allow differentiation among alternatives with respect to effectiveness, implementability, and cost. Results of these evaluations are now used for comparing alternatives within each general response action (GRA) relative to each other. Screening on a relative basis allows for either eliminating alternatives from further evaluation or retaining alternatives for detailed analysis. The purpose of this screening is to refine the list of alternatives to be retained for detailed analysis.

Alternatives may be screened from further consideration on the basis of relative effectiveness within a GRA or if an alternative is not considered implementable. An alternative can only be screened on the basis of cost when the relative effectiveness and implementability of other alternatives are equal. Alternatives can also be screened on the basis of unjustifiable cost relative to increased effectiveness or implementability. The screening process is only a preliminary evaluation, and alternatives are generally retained unless a clear basis for rejection is identified (EPA 1988).

### **11.6.1 Alternative 1: No Action With Monitoring**

As required by the NCP, the No Action with Monitoring alternative is retained for detailed analysis to serve as the baseline for comparing other remedial action alternatives. Review of the BRA leads to the conclusion that “no action” is not an acceptable alternative on the basis of mitigation of identified human health and environmental risks greater than allowable levels.

### **11.6.2 Alternative 2: Institutional control**

The Institutional Control alternative is considered to be effective for protecting human health during the 100-year period of institutional control, but would provide little or no reduction of environmental risks. Deed restrictions are assumed to effectively reduce human exposures to allowable levels indefinitely. This alternative is retained for further consideration only for CFA-08, where no ecological risks were identified.

### **11.6.3 Alternatives 3a and 3b: Removal/Treatment/ICDF Disposal and Removal/Treatment/Off-INEEL Disposal/Institutional Controls**

Both alternatives are retained for all sites. Short-term effectiveness is relatively similar between the two alternatives, while ICDF disposal is more technically implementable because of shorter transportation distance. Offsite disposal has higher long-term effectiveness, since all remediation waste would be removed from the INEEL; however, ICDF disposal is more cost-effective.

Stabilization in Portland cement could be performed either on- or off-INEEL. On-INEEL segmented gate sorting of radioactive soil is retained as a treatment option, pending INEEL pilot demonstration. If SGS treatment is not demonstrated to be cost-effective, then CFA-08 soils could be disposed of directly, either at the ICDF or offsite. Both on- and off-INEEL excavation, treatment and disposal alternatives are retained for detailed analysis for all sites.

### **11.6.4 Alternative 4: Containment and Institutional Control**

Containment using an ET-type cover is considered to be effective in inhibiting exposures via direct radiation exposure, soil ingestion, homegrown produce ingestion, and ecological exposures at OU 4-13 soil contamination sites. This alternative is retained for further consideration at all sites.

### **11.6.5 Alternatives Retained for Further Analysis**

The screening process identified alternatives with favorable composite evaluations of effectiveness, implementability, and cost. Based on the results of screening, the institutional control alternative (Alternative 2) is eliminated from further consideration for CFA-04 and -10, because ecological risks would not be reduced. The institutional control alternative is retained for CFA-08, where no ecological risks were identified, and where access and deed restrictions would limit human health risks for sufficient time for Cs-137 to decay to unrestricted release levels.

Excavation/treatment/disposal/institutional controls (Alternatives 3a and 3b) is retained for all sites. Containment and institutional controls (Alternative 4) using an ET-type cover is retained for all sites.

## **11.7 References**

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.

Keck, J. F., 1992, *Evaluation of Engineered Barriers for Closure Cover of the RWMC SDA*, EDF # RWMC-523, January.